**NATURAL RESOURCES CONSERVATION SERVICE**

**CONSERVATION PRACTICE STANDARD**

# STREAMBANK AND SHORELINE PROTECTION

**(Feet)**

**CODE 580**

## DEFINITION

Treatment(s) used to stabilize and protect banks of streams or constructed channels, and shorelines of lakes, reservoirs, or estuaries.

## PURPOSE

- To prevent the loss of land or damage to land uses, or other facilities adjacent to the banks, including the protection of known historical, archeological, and traditional cultural properties.
- To control channel meander that would adversely affect downstream facilities, while accommodating the natural fluvial processes of the watershed,
- To reduce sediment loads causing downstream damages and pollution.
- To maintain the flow or storage capacity of the water body or to reduce the offsite or downstream effects of sediment resulting from bank erosion.
- To improve or enhance the stream corridor for fish and wildlife habitat, aesthetics, recreation.

## CONDITIONS WHERE PRACTICE APPLIES

This practice applies to streambanks of natural or constructed channels and shorelines of lakes, reservoirs, or estuaries where they are susceptible to erosion. It applies to controlling erosion where the problem can be solved with relatively simple structural measures, vegetation, or upland erosion control practices. It does not apply to erosion problems on main oceanfronts and similar areas of complexity not normally within the scope of NRCS authority or expertise.

## CRITERIA

Because each reach of a channel, lake, or estuary is unique, measures for streambank and shore protection must be installed according to a plan and adapted to the specific site. Practices shall be defined as follows:

**Vegetative -** Woody and herbaceous plants used to reduce streambank erosion and prevent land losses and sediment damages but do not directly stabilize the channel bottom grade.

**Bio-technical -** A system of living plant materials used as structural components to stabilize streambanks. Components include live stakes, live facines, branch packing, vegetated geogrids, live cribwall, joint planting and brush mattress.

**Structural -** A system using hard measures to stabilize streambanks and shorelines. Practices include tree revetments, root wads, dormant post plantings, piling revetments, jacks, riprap, coconut fiber rolls, stream jetties, stream barbs, gabions and concrete or timber retaining walls.

### General Criteria Applicable to All Purposes

Measures must be installed according to a site-specific plan and in accordance with all applicable local, state, and federal laws and regulations.

Protective measures to be applied shall be compatible with improvements planned or being carried out by others.

Protective measures shall be compatible with the bank or shoreline materials, water chemistry, channel or lake hydraulics, and slope characteristics both above and below the water line.

End sections shall be adequately bonded to existing measures, terminate in stable areas, or be otherwise stabilized.

Protective measures shall be installed on stable slopes. Bank or shoreline materials and type of measure installed shall determine maximum slopes. Steep, unstable slopes and deep undercuts in banks and shorelines will require grading to a stable slope or will require structural measures such as tree revetments, root wads, cribwalls, rock riprap, or gabions. For planting purposes, the steepest acceptable slope is 1.5 horizontal to 1 vertical. Slope stability analysis or design shall be subject to acceptable engineering practice and federal, state, and local regulations. Newly graded banks may require protection from overbank flow in accordance with the Standard for Diversion – 362.

Designs will provide for protection from upslope runoff.

Internal drainage for bank seepage shall be provided when needed. Geotextiles or properly designed filter bedding shall be used on structural measures where there is the potential for migration of material from behind the measure.

Measures applied shall not adversely affect threatened and endangered species nor species of special concern as defined by the appropriate state and federal agencies.

Measures shall be designed for anticipated ice action and fluctuating water levels.

All disturbed areas around protective measures shall be protected from erosion. Disturbed areas that are not to be cultivated shall be protected as soon as practical after construction. Vegetation shall be selected that is best suited for the soil/moisture regime.

**Additional Criteria for Streambanks**

The channel grade shall be stable based on a field assessment before any permanent type of bank protection can be considered feasible, unless the protection can be constructed to a depth below the anticipated lowest depth of streambed scour. Excessive bed degradation must be controlled prior to the installation of streambank protection in accordance to standard 584 - Stream Channel Stabilization.

A protective toe shall be provided based on an evaluation of stream bed and bank stability.

Peak discharge and/or hydrographs for capacity shall be determined by using appropriate analysis methods, such as:

- NRCS Technical Release No. 55 or No. 20, U.S. Army Corps of Engineers HEC-1,
- EFH, Chapter 2.
- Johnson and Tasker (March 1974) or other approved methodology.

Channel clearing to remove stumps, fallen trees, debris, and bars shall only be done when they are causing or could cause detrimental bank erosion or structural failure. Habitat forming elements that provide cover, food, and pools, and water turbulence shall be retained or replaced to the extent possible.

Changes in channel alignment shall not be made unless the changes are based on an evaluation that includes an assessment of both upstream and downstream fluvial geomorphology. The current and future discharge-sediment regime shall be based on an assessment of the watershed above the proposed channel alignment.

Measures shall be functional for the design flow and sustainable for higher flow conditions based on acceptable risk.

Measures shall be designed to avoid an increase in natural erosion downstream.

Measures planned shall not limit stream flow access to the floodplain.

Stream segments to be protected shall be classified according to a system deemed appropriate by the state. Segments that are incised or contain the 5-year return period (20 percent probability) or greater flows shall be evaluated for further degradation or aggradation.

When water surface elevations are a concern, the effects of protective measures shall not increase flow levels above those that existed prior to installation. A water surface profile analysis or other appropriate method (such as WSP2, HEC-2), or Manning's formula shall be used to determine the velocities in the channel.

Vegetative protection shall only be installed above the 2-year storm water surface elevation, regardless of whether it requires incorporation with other measures.

Structural and bio-technical measures shall be utilized individually or in combination with other systems to provide an appropriate level of protection based on design flows, velocities and hazard classification of the area being protected. Refer to East Region Supplement #1 to Chapter 16, EFH, for hazard classification system. They shall also be designed to avoid undesirable impacts upstream and downstream.

A minimum of 25 foot buffer width from the top of bank shall be established in grass and/or woody plants.

Appropriate bio-technical measures and installation procedures may be found in EFH Chapter 16 and East Region Supplement.

**Additional Criteria for Shorelines**

All revetments, bulkheads, or groins are to be no higher than 3 feet (1 meter) above mean high tide, or mean high water in non-tidal areas

End sections shall be adequately bonded to existing measures or terminate in stable areas. Structural shoreline protective measures shall be keyed to a depth to prevent scour during low water.

Recommended treatment shall be based on soil type and slope characteristics both above and below the waterline. For the design of structural measures, the site characteristics below the waterline shall be evaluated for a minimum of 50 feet (15 meters) horizontal distance from the shoreline measured at the design water surface.

The height of the protection shall be based on the design water surface plus the computed wave height and freeboard. The design water surface in tidal areas shall be mean high tide.

Vegetative protection shall be encouraged on eroding banks, especially on areas that are not susceptible to frequent or daily inundation. When vegetation is selected as the protective treatment, a temporary breakwater shall be used during establishment when wave run up would damage the vegetation.

A minimum of 25 foot wide buffer area, measured from the top of bank, shall be established in grass and/or woody plants.

Appropriate bio-technical measures and installation procedures may be found in EFH Chapter 16 and East Regional Supplement.

**Additional Criteria for Stream Corridor Improvement**

Stream corridor vegetative components shall be established as necessary for ecosystem functioning and stability. The appropriate composition of vegetative components is a key element in preventing excess long-term channel migration in re-established stream corridors.

Measures shall be designed to achieve any habitat and population objectives for fish and wildlife species or communities of concern as determined by a site-specific assessment or management plan. Objectives are based on the survival and reproductive needs of populations and communities, which include habitat diversity, habitat linkages, daily and seasonal habitat ranges, limiting factors and native plant communities. The type, amount, and distribution of vegetation shall be based on the requirements of the fish and wildlife species or communities of concern to the extent possible.

Measures shall be designed to meet any aesthetic objectives as determined by a site-specific assessment or management plan. Aesthetic objectives are based on human needs, including visual quality, noise control, and microclimate control. Construction materials, grading practices, and other site development elements shall be selected and designed to be compatible with adjacent land uses.

Measures shall be designed to achieve any recreation objectives as determined by a site-specific assessment or management plan. Recreation objectives are based on type of human use and safety requirements.

**Additional Criteria for Vegetative Practices**

Vegetative Practices are woody and herbaceous plants used to reduce streambank erosion and prevent land losses and sediment damages but do not directly stabilize the channel bottom grade.

Plant species must be suitable for the intended use and adapted to the site's climate, soil, and water conditions. Non-native plant species should be avoided. Species that root easily, such as willow, are required for such bio-technical measures as live facines, brushlayering, and live staking or where unrooted stems are used with structural measures. Plant materials will be live, viable, woody or herbaceous vegetation. The plant materials will be obtained from commercial sources or, in the case of woody cuttings, may be harvested from native stands during dormant periods (October - April depending upon location). Plant materials shall be installed singly or in systems as described in USDA - Natural Resources Conservation Service, Engineering Field Handbook, Chapter 16.

Vegetative practices without structural measures may only be considered on low hazard sites. With exception to tree revetments and root wads, structural practices must be used on all medium and high hazard sites. However, vegetation may be incorporated on all medium and high hazard sites to improve fish and wildlife habitat and aesthetics of the site. Exposed bare streambank areas shall be protected by installing erosion control matting such as coconut fiber or jute netting. Allowable velocities for vegetative practices shall not exceed those shown in Table 2 of the East Region Supplement No. 1 to Chapter 16 of the Engineering Field Handbook (EFH).

**Additional Criteria for Riprap, Bedding and Filters**

Riprap and the corresponding bedding or filter layers shall be designed on the following criteria:

The riprap shall be designed for the storm frequency indicated in the stability check column of the Hazard Classification shown in Figure 2 of the NE Region Supplement to Chapter 16, EFH.

Check the stability of the vegetation above the proposed top of riprap using the allowable velocity approach. If vegetation is not stable for the condition, raise the top of rock to the design storm height plus one-foot.

In all cases consider increasing the size of the rock to allow for ice action.

Riprap shall extend at least two feet below the channel bottom in a key trench. This minimum may be reduced when the channel bottom is durable rock.

The slope of the completed riprap shall be 1.5 horizontal to 1.0 vertical or flatter.

Riprap size and gradation shall be designed using Vermont exhibit 16-1 on page 16-21.1 through 16-21.13 of Chapter 16, EFH or other approved methods.

**Filters** - are pervious materials designed to prevent the movement of soil particles out of the bank (base) by seepage water. Filters under riprap must also satisfy the functions of bedding.

Filters are not needed under riprap except where the bank (base) material is a fairly clean, poorly graded sand with a high seepage gradient (flow from the material above normal stream level). NEH Part 633, Chapter 26, "Gradation Design of Sand and Gravel Filters" shall be used to design filters.

The thickness of the filter blanket shall range from 6 inches to 15 inches for single layer and from 4 inches to 8 inches for individual layers of a multiple layer blanket. The minimum thickness maybe used when the gradation curves of adjacent layers are approximately parallel. The thickness should be increased proportionately when the gradation curve of a layer departs from parallel.

**Bedding** - is a layer of granular material used to distribute the riprap load, prevent leaching of bank (base) material by flowing water at the rock surface, and fill voids in the bank (base) in providing a uniform surface for riprap placement.

Bedding or material that fulfills bedding requirements should be used for all riprap installations. Bedding may consist of:

- Suitable off-site gravel.
- Natural on-site gravels or sandy or silty gravels. Sands and silts may leach from the bedding surface after placement.
- At low hazard sites on low gradient streams, riprap that contains 15 to 25 percent gravel size materials may be place without a separate bedding layer.

Bedding should have a maximum of 10 percent fines and should have materials in the 3/4 inch to No. 4 sieve size and some in the 1-1/2 to 3/4-inch sieve size. It may contain sand and/or larger gravels. The bedding layer shall range from 6 inches to 12 inches but may be thicker when necessary to fill inherent voids.

Bank sloping for establishment of vegetation shall be no steeper than 1.5 horizontal to 1.0 vertical. Plantings shall be extended from the normal water level or elevation of protective riprap to the top of bank. Vegetation shall consist of suitable grasses and seedlings or cuttings of adaptable shrubs.

### Additional Criteria for Retaining Structures

Concrete, timber, gabion, cribwalls and other type of retaining structures shall be design in accordance to the following criteria:

Retaining structures shall be designed to resist over turning and sliding forces.

Retaining structures shall be designed in accordance to the appropriate ACI, ASAE or other appropriate codes and standards.

Ice actions shall be taken into consideration in the design.

Weep holes or other drainage system shall be design to allow water from behind the retaining structure to drain freely.

## CONSIDERATIONS

An assessment of streambank or shoreline protection needs should be made in sufficient detail to identify the causes contributing to the instability (e.g. watershed alterations resulting in significant modifications of discharge or sediment production). Due to the complexity of such an assessment an interdisciplinary team should be utilized.

When designing protective measures, consider the changes that may occur in the watershed hydrology and sedimentation over the design life of the measure.

Consider utilizing debris removed from the channel or streambank into the treatment design.

Use construction materials, grading practices, vegetation, and other site development elements that minimize visual impacts and maintain or complement existing landscape uses such as pedestrian paths, climate controls, buffers, etc. Avoid excessive disturbance and compaction of the site during installation.

Utilize vegetative species that are native and/or compatible with local ecosystems. Avoid introduced or exotic species that could become nuisances. Consider species that have multiple values such as those suited for biomass, nuts, fruit, browse, nesting, aesthetics and tolerance to locally used herbicides. Avoid species that may be alternate hosts to disease or undesirable pests. Species diversity should be considered to avoid loss of function due to species-specific pests. Species on noxious plant lists should not be used.

Livestock exclusion should be considered during establishment of vegetative measures and appropriate grazing practices applied after establishment to maintain plant community integrity. Wildlife may also need to be controlled during establishment of vegetative measures. Temporary and local population control methods should be used with caution and within state and local regulations.

Vegetative measures that promote beneficial sediment deposition and the filtering of sediment, sediment-attached, and dissolved substances should be considered.

Consider maintaining or improving the habitat value for fish and wildlife, including lowering or moderating water temperature, and improving water quality.

Consideration should be given to protecting side channel inlets and outlets from erosion.

Toe rock should be large enough to provide a stable base and graded to provide aquatic habitat.

Consider maximizing adjacent wetland functions and values with the project design and minimize adverse effects to existing wetland functions and values.

When appropriate, establish a buffer strip and/or diversion at the top of the bank or shoreline protection zone to help maintain and protect installed measures, improve their function, filter out sediments, nutrients, and pollutants from runoff, and provide additional wildlife habitat.

Consider conservation and stabilization of archeological, historic, structural and traditional cultural properties when applicable.

Measures should be designed to minimize safety hazards to boaters, swimmers, or people using the shoreline or streambank.

Protective measures should be self-sustaining or require minimum maintenance.

Consideration shall be given to the water quantity effects on the water budget, especially on volumes and rates of runoff, infiltration, deep percolation, and water recharge.

Consideration shall be given to the water quantity effects on downstream flows and aquifers that affect other uses and users.

Consideration shall be given to the water quantity effects on the water table of adjoining fields and the effects on the interflow discharge into streams.

Planning, design and installation of this practice will be performed in accordance with acceptable engineering practice and local, state, and federal government regulations. This shall include Vemont's Accepted Agricultural Practices, local ordinances on stream buffer width and "Streambank and Lakeshore Vegetation Management (June 16, 1996)" by the VT Agency of Natural Resources, VT Dept. of Fish and Wildlife and, VT Dept. of Forest, Parks and Recreation.

Cost of measures vary widely and must be evaluated closely for monetary cost versus risk.

Transportation cost of measures can contribute significantly to the expense of the practice and must be evaluated carefully.

Plant materials of adequate quantity and quality are often a scarce resource. Their availability is critical to bio-technical solutions.

In situations where a key trench cannot be installed due to a durable rock stream bottom, the riprap should be pinned to the stream bottom by installing a minimum of one - one inch diameter steel pin per five feet of stream bank. Pins should be drilled and grouted into the first coarse of riprap rock and at least 18 inches in to the stream bottom. The pin should not extend above the first coarse of rock on the stream bank.

Where it is not feasible to key the toe of riprap into the stream bottom due to access or depth of water, additional riprap bulk may be added to the toe to compensate.

**PLANS AND SPECIFICATIONS**

Plans and specifications for streambank and shoreline protection shall be prepared for specific field sites and based on this standard and shall describe the requirements for applying the practice to achieve its intended purpose. Plans and specifications shall include construction plans, drawings, job sheets, construction specifications, narrative statements in conservation plans, or other similar documents. These documents are to specify the requirements for installing the practice, such as the kind, amount, or quality of materials to be used, or the timing or sequence of installation activities.

## OPERATION AND MAINTENANCE

An operation and maintenance plan shall be prepared for use by the owner or others responsible for operating and maintaining the system. The plan shall provide specific instructions for operating and maintaining the system to insure that it functions properly. It shall also provide for periodic inspections and prompt repair or replacement of damaged components or erosion. Mechanical protection (tree guards) may be needed on upper zone tree plantings of hardwoods in beaver habitat areas.

## REFERENCES

- Chapter 2, EFH
- Chapter 16, EFH
- Chapter 18, EFH
- TR-20
- TR-55
- HEC-1
- USDA-NRCS National Planning Manual
- East Region Supplement #1, Ch. 16, EFH
- U.S. Army Corps of Engineers
- Vermont Agency of Natural Resources